AMENDMENT TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in this application.

Listing of Claims:

1. (Currently Amended) A method for extracting cerebral ventricular system information from images of one or more cerebral ventricular regions, ~~the cerebral ventricular system comprising a third ventricle (V3), a fourth ventricle (V4), a left lateral ventricle (VLL) having a body (VLL-B) and an inferior (temporal) horn (VLL-I), a right lateral ventricle (VLR) having a body (VLR-B) and an inferior (temporal) horn (VLR-I), an interior~~ ~~anterior~~ ~~commissure (AC), a posterior commissure (PC), and a midsagittal (MSP),~~ the method comprising the steps of:

1) defining multiple regions of interest (ROI) in the images, at least one of the images having multiple ROIs defined within;

2) altering the ROIs based on desired histogram distribution within the ROIs;

[[2]] 3) defining seed points within each ROI;

[[3]] 4) growing images of ventricular regions in 3D space while correcting for leakages into extraventricular space; and

[[4]] 5) connecting the ventricular regions grown;

wherein the steps of defining multiple ROIs, defining seed points and growing images are applied to one or more images of the left ventricle, the right ventricle, the third ventricle and the forth ventricle;and the ROIs are defined each corresponding to one of: a third ventricle (V3), a fourth ventricle (V4), a left lateral ventricle (VLL) having a body (VLL-B) and an inferior (temporal)

horn (VLL-I), a right lateral ventricle (VLR) having a body (VLR-B) and an inferior (temporal) horn (VLR-I), an anterior commissure (AC), a posterior commissure (PC), and a midsagittal (MSP).

2. (Previously Presented) The method according to claim 1, wherein the steps of defining multiple ROIs, defining seed points and growing images are applied first to one or more images of the_third ventricle (V3), then to one or more images of the fourth ventricle (V4), and then to the left and right ventricles (VLL and VLR) for controlling leakage and connections.

3. (Previously Presented) The method according to claim 1, wherein the method is performed from one or more medical imaging modalities.

4. (Previously Presented) The method according to claim 1, wherein the step of defining multiple ROIs comprises defining each ROI in a predetermined plane.

5. (Previously Presented) The method according to claim 4, wherein the step of defining multiple ROIs comprises selecting said predetermined plane to be on a coronal orientation to constitute a coronal slice.

6. (Currently Amended) The method according to claim 5, wherein the step of selecting said predetermined plane to be on the coronal orientation for assessment of an image of the body of the left lateral ventricle or the body of the right lateral ventricle comprises the steps:

(1) selecting the coronal plane (VAC) passing through the anterior commissure (AC); and

(2) selecting the initial rectangular ROI on the VAC laterally between the coordinates [MSP, MSP + nl] for the body of the left lateral ventricle, and [MSP-n1, MSP] for the body of the right lateral ventricle, and dorsally between [AC, AC + n2), where n1 and n2 are constants~~; and~~

~~(3) altering the ROIs for subsequent processing based on desired histogram distribution within the ROIs~~.

7. (Previously Presented) The method according to claim 6, wherein each aspect ratio of the ROIs is constant.

8. (Previously Presented) The method according to claim 7, wherein the sizes of the ROIs are reduced laterally and dorsally.

9. (Previously Presented) The method according to claim 6, wherein n1 is 25 mm.

10. (Previously Presented) The method according to claim 6, wherein n2 is 35 mm.

11. (Previously Presented) The method according to claim 5, wherein the images of the one or more cerebral ventricular regions comprises one or more coronal slices comprised of pixels, and wherein the step of selecting said predetermined plane to be on a coronal orientation

for assessment of an image of the inferior horn of the left lateral ventricle (VLL-I) or the inferior horn of the right lateral (VLR-I) comprises the steps:

1) selecting coronal slices between the coronal plane passing through the anterior commissure (VAC) and the coronal plane passing through the posterior commissure (VPC);

2) drawing a horizontal profile at the level of the inferior pixel of the image of the third ventricle(V3);

3) identifying the temporal bone signal in the horizontal profile as the lateral-most high signal due to bone marrow fat;

4) measuring the distance from the temporal bone to the midsagittal plane (MSP);

5) dividing the distance in half to define a midpoint and considering this midpoint as point "a";

6) drawing an ROI having the dimensions n6 x n6 in reference to the midpoint "a" so that the coordinates are (a, a-n7 (a, a+n7) laterally and (a, a+n6) inferiorly, where n6 and n7 are constants; and

7) maintaining the ROIs for subsequent processing unchanged.

12. (Previously Presented) The method according to claim 11, wherein n6 is 20 mm.

13. (Previously Presented) The method according to claim 11, wherein n7 is 10 mm.

14. (Previously Presented) The method according to claim 1 wherein the ROI for the third ventricle (V3) is set on a sagittal plane by:

1) selecting the midsagittal plane (MSP);

2) setting an initial rectangular R0I antero-posteriorly between the coordinates [AC, PC] and dorsally between [AC – n8, AC + n9], wherein n8 and n9 are constants; and

3) altering the ROIs for subsequent processing based on desired histogram distribution within the ROIs.

15. (Previously Presented) The method according to claim 14, wherein the sizes of the ROIs are reduced by moving the superior boundary of the ROI inferiorily.

16. (Previously Presented) The method according to claim 14, wherein n8 is 10 mm.

17. (Previously Presented) The method according to claim 14, wherein n9 is 35 mm.

18. (Previously Presented) The method according to claim 1 wherein the ROI for the fourth ventricle (V4) is set on a_sagittal plane by:

1) selecting the midsagittal plane (MSP);

2) setting a rectangular ROI posteriorly between [PC, PC + n10] and dorsally between [PC, PC – n11], where n10 and n11 are constants;

3) limiting the superoposterior part of the ROI by drawing a line starting at n12 posterior to PC to the posteroinferior corner of the ROI to bisect the ROI obliquely, where n12 is a constant;

4) limiting the inferoposterior part of the ROI by drawing a line from the inferoanterior corner of the ROI to the midpoint of the posterior limit of the ROI; and

5) altering the ROIs for subsequent processing based on desired histogram distribution within the ROIs.

19. (Previously Presented) The method according to claim 18, wherein the sizes of the ROIs are reduced posteriorly.

20. (Previously Presented) The method according to claim 18, wherein n10 is 50mm.

21. (Previously Presented) The method according to claim 18, wherein n11 is 45mm.

22. (Previously Presented) The method according to claim 18, wherein n12 is 5 mm.

23. (Previously Presented) The method according to claim 18, wherein the desired histogram distribution within said ROIs the peaks corresponding to white matter (WM), grey matter (GM), and cerebrospinal fluid (CSF) in said histogram are identifiable with any existing peak detection algorithm.

24. (Previously Presented) The method according to claim 1, wherein the step of defining seed points within an ROI for VLL-B and VLR-B comprises the steps:

1) sampling the ROI horizontally, starting from AC+n13 every n14 distance, where n13 and n14 are constants to form sample line segments;

2) calculating a profile along each sample line segment;

3) determining the longest CSF segment from said profile; and

4) placing the seed point in the middle of the segment.

25. (Previously Presented) The method according to claim 24, wherein n13 is 10 mm.

26. (Previously Presented) The method according to claim 24, wherein n14 is 5 mm.

27. (Previously Presented) The method according to claim 11, wherein the step of defining seed points for VLL-I and VLR-I comprises the following steps:

1) setting the ROIs for the VLL-I and VLR-I on multiple coronal planes between VAC and VPC, wherein the planes are selected and processed starting from VAC;

2) locating the CSF region on the coronal slice between VAC and VPC having the largest CSF region; and

3) placing the seed point at the geometric centre of said CSF region.

28. (Previously Presented) The method according to claim 18, wherein the step of defining the seed point for V3 comprises the steps:

1) calculating a profile along the line between the anterior and posterior commissures (AC-PC); and

2) determining a pixel on the AC-PC line, whose gray level is closest to the CSF mean value to constitute the seed point.

29. (Previously Presented) The method according to claim 18, wherein the step of defining the seed point for V4 comprises the steps:

1) sampling the ROI horizontally, starting from PC-n15 every n16 distance, where n15 and n16 are constants to generate a sample line segment;

2) calculating a profile along each sample line segment;

3) calculating the length of the CSF in each profile and comparing the calculated length to the previous one; and

4) when the calculated length decreases for at least n17 subsequent slices, select the middle of the longest CSF segment as the seed point, where n17 is any constant.

30. (Previously Presented) The method according to claim 29, wherein n15 is 10 mm.

31. (Previously Presented) The method according to claim 29, wherein n16 is 2 mm.

32. (Previously Presented) The method according to claim 29, wherein n17 is 2 mm.

33. (Previously Presented) The method according to claim 1, wherein each lateral ventricle is grown in 3D space on coronal slices, slice by slice.

34. (Previously Presented) The method according to claim 33, wherein the step of growing the image of the third ventricle V3 comprises:

1) subdividing V3 into four subregions 1, 2, 3 and 4 by the planes passing VAC, VPC, AC-PC, subregion 1 containing the most anterior part of V3 and being separated from subregions 2, 3 and 4 by the VAC and the AC-PC planes, subregion 2 containing the most dorsal part of V3 and being separated from the subregions 1, 3 and 4 by the AC-PC and the VPC planes, subregion 3 containing the most posterior part of V3 and being separated from subregions 1, 2 and 4 by the AC-PC and the VPC planes, and subregion 4 containing the most ventral part of V3 and being separated from the subregions 1, 2, and 3 by the AC-PC and the VAC planes; and

2) growing V3 in three dimensions, wherein subregion 1 is grown anteriorly on coronal slices, subregion 2 and subregion 3 are grown superiorly on axial slices; and subregion 4 is grown inferiorly on axial slices from the seed point.

35. (Previously Presented) The method according to claim 33, wherein the step of growing the image of the fourth ventricle (V4) comprises:

1) subdividing V4 into two subregions 1, and 2, by the axial plane passing through the seed point, subregion 1 including the part of V4 superior to and subregion 2 including the part inferior to the axial plane; and

2) growing V4 on axial slices, dorsally in subregion 1 and ventrally in subregion 2 starting from the axial slice containing the seed point.

36. (Previously Presented) The method according to claim 33, wherein during the growth of the VLL-B and VLR-B regions, the step of correcting for leakages in the extraventicular region comprising the quadrigeminal cistern comprises inhibiting growing of a region below the PC in inferior direction.

37. (Previously Presented) The method according to claim 36, wherein the leakage comprises growth in the area behind the VPC up to the seed point of V4.

38. (Previously Presented) The method according to claim 36, wherein during the growth of the VLL-I and VLR-I regions, the step of correcting for leakages comprises inhibiting the anterior boundaries on the coronal slice to connect with the boundary of the ROI of VLL-I (or VLR-I).

39. (Previously Presented) The method according to claim 34, wherein during the growth of the V3 region the step of correcting for leakages ventrally through the mesencephalic tegmentum to the interpeduncular cistern, comprises:

hindering the width of the foreground region of subregion 1 on a coronal slice from increasing by more than 50% of the width of the previous slice along anterior direction.

40. (Previously Presented) The method according to claim 34, wherein during the growth of the V3 region the step of correcting for leakages posteriorly through the PC (stalk of the pineal body) to the cisterna ambiens, comprises:

1) limiting the maximum width of foreground region of subregion 3 on an axial slice to be on PC line; and

2) maintaining the distance between the centre of gravity of the foreground region of subregion 3 and the MSP less than n18, where n18 is a predetermined constant.

41. (Previously Presented) The method according to claim 40, wherein n18 is 4 mm.

42. (Previously Presented) The method according to claim 35, wherein during the growth of the V4 region the step of correcting for leakages dorsoposteriorly through the superior medullary velum to the cisterna ambiens, comprises:

1) hindering the number of foreground pixels of the current axial slice from increasing by 50% more than that in the previous slice in the inferior direction; and

2) maintaining the distance between the centre of gravity of the foreground region of V4 and the MSP less than 2 mm.

43. (Previously Presented) The method according to claim 35, wherein during the growth of the V4 region the step of correcting for leakages ventroposteriorly through

the inferior medullary velum to the cisterna magna, comprises maintaining the width of the foreground region of V4 at the lateral recesses less than 2 mm.

44. (Previously Presented) The method according to claim 34, further comprising repeating the region growing with narrower growing ranges after detection of leakage.

45. (Previously Presented) The method according to claim 44, wherein the step of repeating the region growing with narrower growing ranges comprises narrowing the intensity range and/or the spatial range of the growing region.

46. (Previously Presented) The method according to claim 45, wherein the narrowing of the intensity range comprises decreasing the value of the scaling factor s, in the equation defining the growing range of intensity $[\mu - s*(\mu - m), \mu + s*(M - \mu)]$, wherein **m** is the minimum, **M** the maximum and **μ** the mean values of the CSF range and **s** is a scaling factor between 0 and 1.

47. (Previously Presented) The method according to claim 46 wherein the narrowing of the intensity range is performed iteratively by decreasing the value of **s**, followed by performing the region growing again and checking whether the leakage is avoided.

48. (Previously Presented) A method for extracting cerebral ventricular system information from images of one or more cerebral ventricular regions, the cerebral ventricular system comprising a third ventricle (V3), a fourth ventricle (V4), a left lateral ventricle (VLL) having a body (VLL-B) and an inferior (temporal) horn (VLL-I), a right lateral ventricle (VLR) having a body (VLR-B) and an inferior (temporal) horn (VLR-I), an anterior commissure (AC), a posterior commissure (PC), and a midsagittal (MSP), the method comprising:

A) defining multiple regions of interest (ROI) in the images;

B) defining seed points within each ROI;

C) growing images of ventricular regions while correcting for leakages into extraventricular space; and

D) connecting the ventricular regions grown;

wherein the step of connecting the ventricular regions VLL-B and VLL-I comprises:

1) locating the leftmost inferior pixel of [VLR-B, P_l] where P_l is the left most inferior pixel of VLR-B;

2) growing VLR-I on a coronal slice in a posterior direction;

3) checking whether the number of foreground region is equal to or less than 1; if not, go to 4); if yes,

- find the minimum rectangular area containing all the foreground pixels of the previous coronal slice in anterior direction;
- pass the rectangular area to the current coronal slice C_{cur} ;

- find a seed point for the grey matter at the rectangular area, and extract the grey matter through region growing; if the seed point cannot be found or the grey matter is absent, go to 7) for brute-force connection;
- trace the leftmost superior boundary of the grey matter;
- add the traced pixels to the grown region, and go to 5);

4) checking whether the number of foreground region(s) is more than 1 on C_{cur}; if not, go to 5); if yes, connect the foreground regions by the following steps:

- locate the P_2 and P_3 pixels on the foreground regions, where P_2 is the leftmost inferior pixel of the upper foreground region and P_3 is the leftmost superior pixel of the lower foreground region;
- trace the boundary of the grey matter between P_2 and P_3; and
- add the traced pixels to the grown region;

5) checking whether the current grown region is connected with the grown region on the previous coronal slice in anterior direction; if not, connect them;

6) checking whether P_1 is on the current coronal slice; if not, go to 2); if yes, terminate the current connection process;

7) enforcing the brute-force connection when either the seed point is not found or the grey matter is absent; and

8) forming a cone from P_1 and the last grown region to complete the connection.

49. (Previously Presented) A method for extracting cerebral ventricular system information from images of one or more cerebral ventricular regions, the cerebral ventricular system comprising a third ventricle (V3), a fourth ventricle (V4), a left lateral ventricle (VLL) having a body (VLL-B) and an inferior (temporal) horn (VLL-I), a right lateral ventricle (VLR) having a body (VLR-B) and an inferior (temporal) horn (VLR-I), an anterior commissure (AC), a posterior commissure (PC), and a midsagittal (MSP), the method comprising the steps of:

A) defining multiple regions of interest (ROI) in the images;

B) defining seed points within each ROI;

C) growing images of ventricular regions while correcting for leakages into extraventricular space; and

D) connecting the ventricular regions grown;

wherein the step of connecting the ventricular regions V3 and V4 after finishing segmentation of V3 and the subregion 1 of V4 comprises:

1) extracting the connection in the superior direction by:

(a) locating the superior connection starting pixel (Q_1) at the posterior inferior part of V3; and

(b) locating the most superior pixel of subregion 1 of V4 (Q_2) assuming the location is inferior to the PC, is at the most posterior inferior part of V3 and is nearest to the MSP;

2) checking whether Q_1 and Q_2 have the same location; if yes, V3 is connected with V4, and the current connection is terminated;

3) if no, determining a rectangular area around a pixel on the axial slice next to the reference slice A_R in the superior direction, the reference slice A_R being the axial slice with Q_2;
4) growing a region on the axial slice next to A_R in superior direction; if the number of pixels grown is zero, go to (7) to force the connection;
5) checking whether the grown region connects with the subregion 1 of V4; if not, connect the grown region with the subregion 1 of V4;
6) adding the grown region into subregion 1 of V4; assigning the current axial slice as the reference slice A_R; locate the intersection pixel (IP) of the line connecting Q_1 and Q_2 with the axial plane in the superior direction of the grown region and make Q_2, the IP, then go to (2);
7) applying a brute-force connection, by considering the IP in each axial slice as the connection.

50. (Previously Presented) An apparatus arranged to perform a method according to claim 1.

51. (Currently Amended) ~~[[An]]~~ The apparatus according to claim 50, wherein the apparatus is a computing apparatus.

52. (Cancelled)

53. (Previously Presented) A method of quantifying the ventricular system by counting the number of voxels of the ventricular system extracted by a method as claimed in claim 1 and multiplying this count by voxel volume.